OPTIONAL FORM NO. 10

UNITED STATES GOVERNMENT

Memorandum

TO : AD/OEL

DATE: 10 December 1964

FROM : DAD/S&D

SUBJECT:

25X1A

You will recall that [redacted] wanted to set up a measurement program on Ionospheric effects on tracking accuracy. I ask [redacted] for a fast paper and pencil study on what the prognosis looked like. This paper indicates they wouldn't be worthwhile doing.

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[redacted]

ASD-033/64

8 December 1964

MEMORANDUM FOR: Deputy Assistant Director for Systems and Development

SUBJECT : Ionospheric Effects on Tracking Accuracy at 160 mc

1. At the request of the DAD/S&D a cursory examination was made to determine if the ionosphere could be expected to significantly effect the tracking accuracy of a 160 mc radar. It was important to determine if the problem were trivial or one requiring further investigation.

2. Using the paper by Lawrence et al. cited at the end as the principal reference, it was found that non-negligible errors in both range and angle could be expected to occur and that their dependence on time of day, season, etc. as well as the degree to which they can be compensated for should be further investigated. The range error can probably be kept to an acceptable limit if an attempt is made to predict the total electron content and a correction for it is made; i.e., perhaps a correction of $\pm$ 50% can be made. The angular error at the ground, however, cannot be corrected to better than a factor of two even if actual observations of the ionosphere are available at the time and place of interest. Both errors are most severe at the horizon. No effort was made to compare these with other sources of error.

3. The range delay, due to the fact that the group velocity of the wave is less than the velocity of light, is given by

$$\Delta T = 1.35 \times 10^{-7} \frac{\sec i}{f^2} \int_0^S N(z)\, dz \text{ seconds}$$

where f is the frequency in cps, i is the angle of incidence at the ionosphere (say at the F^2 layer) and the integral represents the total electron content (electrons/m^2) in traversing the ionosphere at vertical incidence, assuming no horizontal gradients exist. Choosing 1.8×10^{17} electrons/m^2 as a total content representative of a quiet ionosphere at middle-

latitudes, the delay becomes

$$\Delta T = .95 \times 10^{-6} \sec i \quad \text{seconds}$$

In the absence of any on the spot sounding information and assuming that the error in predicting the electron content is half of the value used above, the resultant delays are approximately 0.5 microseconds overhead and 2.0 microseconds at the horizon. The corresponding range errors are 500 ft. and 2000 ft.

4. Based on the fiftieth percentile curve for total spherical refraction, Figure 14 of Lawrence et al., one gets the attached figure. The estimate of the angular error at the ground was obtained by doubling the total refraction at 160 mc, a procedure which Figures 9 and 10 of the same reference indicate holds at 20 mc.

REFERENCES

R. S. Lawrence et al., "A Survey of Ionospheric Effects Upon Earth-Space Radio Propagation", Proc. IEEE, Vol. 52, pp. 4-27, Jan. 1964.

J. C. Seddon, "A Model of the Quiet Ionosphere", J. of Geophys. Res., Vol. 68, No. 5, pp. 1339-1345, March 1, 1963.

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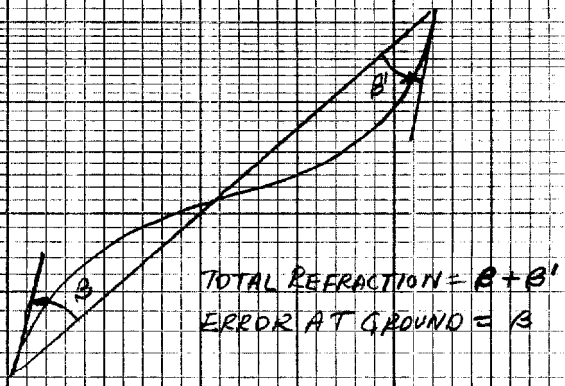
[redacted]

Advanced Projects Branch

Attachment: A/S

Distribution:
Orig. - Addressee w/att.

ORDER OF MAGNITUDE ESTIMATE
OF IONOSPHERIC REFRACTIVE ERROR
AT 162 MC.



DEGREES EXCEEDED 50% OF THE TIME

TOTAL REFRACTION

ANGULAR ERROR AT GROUND

APPARENT ELEVATION ANGLE (DEGREES)

SEMI-LOGARITHMIC 359-71G
KEUFFEL & ESSER CO. MADE IN U.S.A.
3 CYCLES X 70 DIVISIONS

ROUTING AND RECORD SHEET

SUBJECT: (Optional)

FROM:	EXTENSION	NO.
APB/ASD/OEL		ASD-033/64
		DATE 8 December 1964

TO: (Officer designation, room number, and building)	DATE RECEIVED	DATE FORWARDED	OFFICER'S INITIALS	COMMENTS (Number each comment to show from whom to whom. Draw a line across column after each comment.)
1. SA/ASD/OEL	8/12/64	8/12/64	H.W.W.	
2. C/ASD/OEL		8/12/64	PROB	
3. DAD/S&D			[signature]	Retention
4. AD/OEL				Information
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